



March 15, 2021

The Honorable Chair and Members
of the Hawai'i Public Utilities Commission
Kekuanao'a Building, First Floor
465 South King Street
Honolulu, Hawai'i 96813

Dear Commissioners:

Subject: Docket No. 04-0113 – Hawaiian Electric 2005 Test Year Rate Case
Hawaiian Electric Annual Calibration Factor Report for Year 2020

Enclosed for filing is Hawaiian Electric Company, Inc.'s ("Hawaiian Electric" or "HECO") annual calibration factor report for 2020.¹ Hawaiian Electric files this report in accordance with the Stipulated Settlement Letter executed between Hawaiian Electric, the Division of Consumer Advocacy of the Department of Commerce and Consumer Affairs ("Consumer Advocate"), and the Department of the Navy, on behalf of the Department of Defense ("DOD") in the subject proceeding. The Stipulated Settlement Letter, filed with the Commission on September 16, 2005, paragraph 4.a. of Exhibit II states: "For purposes of settlement, the Consumer Advocate and the DOD agree with HECO's proposal to incorporate use of the 2004 calibration factor in determining the test year fuel expense, as HECO in turn agrees to the same calibration reporting requirements that were required of HELCO in Docket No. 99-0207."

Very truly yours,

/s/ Dean K. Matsuura

Dean K. Matsuura
Director, Regulatory Rate Proceedings

Enclosure

cc: Division of Consumer Advocacy
Dr. Kay Davoodi, Department of Defense
James J. Schubert, Department of Defense

¹ In accordance with Order No. 37043 *Setting Forth Public Utilities Commission Emergency Filing and Service Procedures related to COVID-19* (non-docketed), issued by the Commission on March 13, 2020, the Companies are serving this filing on the Consumer Advocate and the DOD via email.

Hawaiian Electric Company, Inc.
Annual Calibration Factor Report for Year 2020
March 15, 2021

1.0 Introduction

This document provides to the Hawai'i Public Utilities Commission ("Commission"), the Division of Consumer Advocacy of the Department of Commerce and Consumer Affairs ("Consumer Advocate") and the Department of the Navy, on behalf of the Department of Defense ("DOD"), Hawaiian Electric Company, Inc.'s ("Hawaiian Electric") calibration factors for calendar year 2020 in accordance with the Stipulated Settlement Letter filed with the Commission on September 16, 2005 in Docket No. 04-0113 (Hawaiian Electric's Test Year 2005 Rate Case) and with the Commission's Interim Decision and Order No. 22050 issued on September 27, 2005, in that docket.

The calibration factors for year 2020, based on recorded January through December 2020 data, are shown in Table 1. Details on the derivation of these calibration factors are discussed in the sections below.

Table 1. 2020 Calibration Factors of Hawaiian Electric Power Plants

Plant	PLEXOS Calibration Factor
Kahe Power Plant	1.011
Waiau Power Plant Steam Units	1.006

2.0 Background

2.1 Calibration Factor

The purpose of a calibration factor in the context of a rate case is to adjust the fuel consumption determined by a computer production simulation to account for actual operating conditions that are not accurately simulated by the computer model. The calibration factor is a constant number that can be greater than, equal to, or less than 1.00. The test year fuel consumption (in Btus) determined by the production simulation is multiplied by this factor.

2.2 Commission Decision and Order

The Commission's Decision and Order No. 18365, issued on February 8, 2001, in Docket No. 99-0207 (Hawai'i Electric Light Company, Inc.'s Test Year 2000 rate case), requires Hawai'i Electric Light Company, Inc. ("Hawai'i Electric Light") to file annual reports on the calibration factor. By Order No. 19196, issued on February

7, 2002, in Docket No. 99-0207, the Commission approved changing the due date for the calibration factor report to March 15th of each year.

Hawaiian Electric is submitting this report in accordance with its agreement¹ to abide by the same calibration factor reporting requirements that were required of Hawai'i Electric Light in Docket No. 99-0207.

3.0 Determination of the Calibration Factor - Analytical Methodology

A calibration factor is determined by using a computer model to simulate the operation of the utility production system for a recorded year, called the "calibration year," and determining the ratio between the computer model outputs and recorded amounts for the calibration year.

3.1 Production Simulations

Hawaiian Electric uses a computer model, called PLEXOS, developed by Energy Exemplar Pty Ltd., to perform production simulations. This model has been set up to simulate the chronological, hour-by-hour operation of Hawaiian Electric's generation system by dispatching the hourly megawatt load demand among the available generating units.

All units are considered as generating units in PLEXOS. Specific capabilities of each unit are assigned through memberships and properties.

3.1.1 Generating units

The generating units modeled in PLEXOS include: (1) all Hawaiian Electric owned generators, (2) Kalaeloa, (3) AES, (4) H-POWER, and (5) all variable generation producers from which Hawaiian Electric purchases energy. Unit commitment and dispatch levels are based on fuel cost, unit characteristics, markups, and other modeling constraints. The units are dispatched by PLEXOS such that the overall fuel expenses of the system are minimized. The model calculates the fuel consumed using the unit dispatch described above, based on the load carried by the unit and the unit's efficiency characteristics.

¹ On September 16, 2005, Hawaiian Electric filed a Stipulated Settlement Letter ("Settlement Letter") that documented certain agreements between Hawaiian Electric, the Consumer Advocate and the Department of Defense ("DOD") regarding matters in Hawaiian Electric's Test Year 2005 rate case proceeding. Exhibit II, Paragraph No. 4.a. of the Settlement Letter stated, "For the purposes of Settlement, the Consumer Advocate and the DOD agree with HECO's proposal to incorporate use of the 2004 calibration factor in determining test year fuel expense, as HECO in turn agrees to the same calibration factor reporting requirements that were required of HELCO in Docket No. 99-0207."

Currently, there are operating restrictions for Campbell Industrial Park (“CIP”) CT-1 due to requirements per the Covered Source Permit (“CSP”) No. 0548-01-C, which states:

CIP is intended to provide spinning reserve by being online and dispatched within ten (10) megawatts (MW) of the minimum operating load. Except during source performance test and activities specified in Attachment IIa, Special Condition Nos. C.9.a and C.9.b, CIP may be dispatched at higher loads only when the steam units at other plants are not reasonably able to serve system needs. Steam units at other plants are HECO boilers: Kahe Generating Station Units 1, 2, 3, 4, 5, and 6; Honolulu Generating Station Units 8 and 9; and Waiiau Generating Station Units 3, 4, 5, 6, 7, and 8. The Department of Health reserves the right to review dispatch records to determine compliance with this condition.

In order to model the operating restrictions for CIP CT-1 due to the CSP requirements, an hourly constraint is used to restrict CIP CT-1’s operating cap to approximately 50 MW, which is roughly ten MW above the current minimum operating load of 41.2 MW.

In May 2018, the biofuel operation previously assigned to CIP CT-1 was transferred to Schofield Generating Station (“SGS”). In order to capture the required fuel usage for the SGS units, a monthly minimum fuel delivery input based on the actual fuel usage for the year was used in the model.

Variable generation producers, including Kahuku Wind Power, Kawaihoa Wind, Na Pua Makani Wind, Kapolei Sustainable Energy Park, Kalaeloa Solar Two, Kalaeloa Renewable Energy Park, Waianae Solar, Lanikuhana Solar, Waipio PV, Kawaihoa Solar, West Loch PV, and feed-in tariff (“FIT”) Tier 3 projects, were represented in the model as generating units with fixed hourly generation based on historical energy production.

IES Downstream, Par Hawaii, and FIT Tier 1 and 2 purchases are represented as generating units with monthly energy targets according to historical purchased energy.

3.1.2 Monte Carlo Options

Hawaiian Electric uses the Monte Carlo scheduling option in PLEXOS for forced outages.

3.2 Calibration Factor Calculation

The production simulation results for the calibration year are compared to the actual recorded data for the calibration year and a calibration factor is derived using actual and simulated fuel consumption, energy generated, and unit heat rates. The following sections provide an explanation of how the actual and simulated fuel consumption, energy generation, and unit heat rates are used when calculating the calibration factor. Actual 2020 data are taken from Hawaiian Electric's production report, which is shown in Appendix B, Table B-1. Simulated data are taken from PLEXOS output reports from the production simulation.

3.2.1 Fuel Consumption

Actual fuel consumption by each power plant is recorded by Hawaiian Electric in barrels consumed and in MBtus. The actual amount of fuel consumed by Hawaiian Electric units in MBtus is used in calculating the actual system-wide heat rate explained in section 3.2.3.

The results from PLEXOS production simulations display the simulated fuel, in MBtus, consumed by each unit. The simulated amount of fuel consumed by Hawaiian Electric units is calculated by summing the MBtus consumed by all Hawaiian Electric-owned units and is used in the calculation of the system-wide calibration factor. This is explained in more detail in section 3.2.4.

3.2.2 Energy Generated

The actual net energy in kWh generated by each unit is recorded on Hawaiian Electric's production reports. The calibration factor calculation uses the total net kWh (converted into MWh) generated by Hawaiian Electric-owned units.

The outputs from the PLEXOS production simulation list the total net GWh generated by each unit for the calibration year. The simulated net energy generated is calculated by summing the GWh generated by all Hawaiian Electric-owned units. The GWh are converted into MWh for the calibration factor calculation. An explanation of how the calibration factor calculation uses the simulated net energy generated by the Hawaiian Electric-owned units is explained in Section 3.2.4.

3.2.3 Actual Heat Rate

For the calibration factor calculation, the actual net heat rate using recorded values from the calibration year is calculated. The actual net heat rate, in Btu/kWh, is Hawaiian Electric's fuel consumption divided by the total net energy generated by the units previously discussed.

3.2.4 Calibration Factor

The calibration factor is the ratio between the actual heat rate and the simulated heat rate from the PLEXOS model for the calibration year. The simulated fuel consumption in MBtus is divided by the simulated net energy generated to obtain the simulated heat rate. The actual heat rate is then divided by the simulated heat rate from the production simulation to obtain the calibration factor.

4.0 Calibration Factor Results for Year 2020

The calibration factors for year 2020, based on recorded January through December 2020 data, are: 1.011 and 1.006 for Kahe Power Plant and Waiau Steam Units respectively. In comparison, the calibration factors for calendar year 2019 were 1.008 and 1.006 for Kahe Power Plant and Waiau Steam Units respectively. Honolulu, CIP, and SGS Power Plants are not included in the 2020 calibration.

The worksheet showing the calculation of the 2020 factors is shown in Table A-1 of Appendix A.

4.1 Specific Assumptions

The key inputs to the production simulation models, when applied to the Hawaiian Electric system, are as follows:

- energy and hourly load to be served by the Hawaiian Electric system,
- energy and hourly load to be served by firm and non-firm purchased power producers,
- load carrying capability of each Hawaiian Electric and firm power producer generating unit,
- efficiency characteristics of each Hawaiian Electric and firm power producer generating unit,
- penalty factors used to dispatch Hawaiian Electric units,
- operating constraints such as must-run units or minimum energy purchases from purchased power producers,
- actual planned maintenance outages for the generating units,
- estimated forced and unplanned maintenance outages for the generating units,
- actual prices for fuels used by the generating units. These are the same prices used in the Energy Management System to dispatch the units.

4.2 Differences between 2020 Modeled and Actual Results

The results from the production simulation were compared to the actual recorded energy and run time for the system. The PLEXOS net energy and run time comparisons are shown in Figures A-1 and A-2 of the Appendix A, respectively. The

largest deviations between the production simulation and actual results were in the cycling and peaking units. However, only units consuming LSFO are shown in this year's calibration. The noticeable differences include, but are not limited to, the following:

Generated energy of individual units in the production simulation varies from actual due to increasing amounts of variable wind and solar resources on O'ahu. The unpredictability of these variable generation resources results in a different commitment and dispatch of units during actual operations than the production simulation, which optimizes around perfect forecast knowledge of variable generation resources. In addition, because the production simulation uses hourly increments to simulate the commitment and dispatch of units, it does not account for variations of variable generation resources as seen in actual operations.

4.3 Reasons for Differences in 2020 Modeled and Actual Results

The actual operating conditions of the utility system are simulated in the computer model as accurately as possible; however, there are some operating conditions that cannot be accurately simulated in the model. Whenever there is a difference between actual and modeled operation, there will likely be a difference between actual and modeled production statistics. The operating conditions that cannot be accurately simulated by the computer model include, but are not limited to:

- temporary unit deratings
- changes in unit dispatch order
- unpredictable output variations of intermittent, variable generation resources
- actual system conditions, such as generating unit or transmission line forced outages
- actual system load
- actual steam turbine and combustion turbine performance
- independent power producer temporary unit deratings and performance

4.3.1 Temporary Unit Deratings

Not all actual unit deratings that occurred in the calibration year are reflected in the production simulation. Since unit deratings can happen at any time and are unpredictable, deratings are generally not reflected in the models.

4.3.2 Changes in Unit Dispatch Order

Not all changes in unit dispatch that occurred in the calibration year can be reflected in the production simulation. There are several reasons why changes in unit dispatch could occur, these reasons include, but are not limited to, the following:

- a. a unit which has a problem with a piece of auxiliary equipment may be dispatched differently from modeled assumptions; and
- b. Hawaiian Electric System Operation sometimes changes the unit dispatch when outages occur on any of several transmission lines either unexpectedly through contingencies or for maintenance work.

4.3.3 Actual System Conditions

There were unpredictable events that occurred in 2020 that the production simulation could not accurately simulate. These events include, but are not limited to the following:

- a. Actual forced outage events, partial and full outages, are incorporated into the computer model using the equivalent forced outage rate demand (“EFORD”) percentage over the entire year. Therefore, the modeled forced outages may not occur at the same times or for the same durations as the actual outages. This will result in some differences in unit dispatch between modeled and actual results.
- b. The planned and unplanned maintenance outage schedules for H-POWER, Kalaeloa, AES, and all the Hawaiian Electric thermal units are obtained from Hawaiian Electric Power Supply Generation Division’s schedule. However, the computer models generally reflect planned and unplanned maintenance outages to the nearest 24 hour period. For example, on the first or last day of an outage, a unit could be unavailable for 15 hours, rather than a full 24 hours (as modeled).
- c. Under normal operating conditions, Hawaiian Electric carries a 180 MW spinning reserve which is equivalent to the unit rating of largest single unit on the system, AES. During periods when AES is on maintenance, Hawaiian Electric carries approximately 135 MW of spinning reserve, which is approximately the amount of the next largest units on the system, Kahe Units 5 and 6. In addition to spinning reserve, Hawaiian Electric has increased its regulating reserves to maintain the minute-to-minute balance between supply and demand of electricity on O‘ahu based on a formula developed by General Electric for estimating the amount of regulating reserve necessary for O‘ahu. The required regulating reserve amount equals either:

Approximately 1 MW regulating reserve for each 1 MW of delivered wind and PV generation up to 18% of nameplate capacity of wind and PV during daytime the hours of 7 AM to 6 PM; or 1 MW regulating reserve for each 1 MW of delivered wind and PV generation up to 23% of nameplate capacity during the hours of 6 PM to 7 AM.

In reality, there may have been instances when there was more or less reserve at any given hour than what was captured in the model.

A joint effort between Hawaiian Electric and the Electric Power Research Institute (“EPRI”) has led to development and implementation of dynamic regulating reserve tools based on short term forecasts. In 2020, Hawaiian Electric’s System Operation began calculating reserves using EPRI’s DynADOR and FESTIV models. Due to the dynamic nature of the DynADOR and FESTIV reserve forecasts based on short term forecasts and current system conditions at that time, Hawaiian Electric’s calibration factor production simulations used its long term regulating reserve concepts described above.

- d. Transmission line maintenance work required additional generating units to be dispatched to provide voltage support to the grid.
- e. Changing system conditions due to increased photovoltaic and wind installations impact generating unit commitment schedules and dispatch levels.

5.0 Observations

Differences in system operating conditions affect the calibration factor from year to year as reviewed in section 4.3.3 above. For PLEXOS production simulations, continuing refinement of modeling techniques and capabilities will need to be sustained into the future to simulate the changing system conditions and resources on the island.

6.0 Future Calibration Factors

As the amount of variable generation resources (such as wind, solar and hydro resources) on the grid increases, the numerical value of the calibration factor is likely to change. This is because system fuel efficiency will likely vary in a way that the model cannot accurately capture. The fuel efficiencies of the generating units over their load range are determined by field tests under steady-state conditions. Under actual, dynamic conditions, where the generating units are continuously ramping up and down on a minute-to-minute basis to counteract the fluctuating outputs of the variable generating units in order to keep supply and demand in balance, the fuel efficiencies of the generating units will be lower than

under steady-state conditions. The model will not be able to accurately capture this and the difference between modeled fuel consumption and actual fuel consumption will be larger compared to when there is little variable generation on the grid. The high degree of uncertainty and variability of future conditions may lead to a broad range of results.

APPENDIX

A. Calibration Year 2020 Workpapers

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Table A-1**2020 PRODUCTION SIMULATION - CALIBRATION RUN**

Kahe			
Actual Net MWH	=	2,377,695	
Actual MBTU	=	25,321,441	
Simulated Net MWH	=	2,142,390	
Simulated MBTU	=	22,567,849	
<hr/>			
Actual Heat Rate	=	10,650	
Simulated Heat Rate	=	10,534	
Calibration Factor	=	1.011	

Waiau Plant			
Actual Net MWH	=	720,453	
Actual MBTU	=	7,937,315	
Simulated Net MWH	=	561,972	
Simulated MBTU	=	6,155,994	
<hr/>			
Actual Heat Rate	=	11,017	
Simulated Heat Rate	=	10,954	
Calibration Factor	=	1.006	

Total LOW SULFUR FUEL OIL*			
Actual Net MWH	=	3,098,148	
Actual MBTU	=	33,258,755	
Simulated Net MWH	=	2,704,363	
Simulated MBTU	=	28,723,843	
<hr/>			
Actual Heat Rate	=	10,735	
Simulated Heat Rate	=	10,621	
Calibration Factor	=	1.011	

Table A-2a

COMPARISON OF PLEXOS TO ACTUALS
2020 CALIBRATION
HEAT RATE (Btu/kWh)

	Kahe			Waiau		
	PLEXOS	ACTUAL	% DIFF	PLEXOS	ACTUAL	% DIFF
Jan	10346.7	10569.9	2.11%	10486.7	10741.8	2.37%
Feb	10447.4	10594.2	1.39%	10716.8	10938.1	2.02%
Mar	10638.9	10555.4	-0.79%	11077.8	10854.9	-2.05%
Apr	10631.9	10714.7	0.77%	11056.7	11125.7	0.62%
May	10711.6	10927.7	1.98%	11151.0	10354.7	-7.69%
Jun	10570.1	10586.3	0.15%	11124.3	11220.8	0.86%
Jul	10358.2	10463.7	1.01%	11003.8	11466.4	4.03%
Aug	10492.3	10633.9	1.33%	11119.5	11092.6	-0.24%
Sep	10620.2	10742.9	1.14%	11163.4	11414.9	2.20%
Oct	10529.2	10650.6	1.14%	10948.8	11210.3	2.33%
Nov	10589.2	10616.3	0.26%	11348.4	11134.3	-1.92%
Dec	10658.0	10809.5	1.40%	11088.5	10964.5	-1.13%
Year	10534.0	10649.6	1.09%	10954.3	11017.1	0.57%

Table A-2bCOMPARISON OF PLEXOS TO ACTUALS
2020 CALIBRATION

Unit	Net GWHs		% of Net Gen		
	PLEXOS	ACTUAL	PLEXOS	ACTUAL	DIFF
Waiau 3	1	-1	0.02%	-0.02%	0.03%
Waiau 4	3	9	0.06%	0.16%	-0.10%
Waiau 5	28	55	0.47%	0.93%	-0.46%
Waiau 6	51	97	0.86%	1.65%	-0.79%
Waiau 7	92	84	1.57%	1.43%	0.14%
Waiau 8	387	476	6.57%	8.09%	-1.52%
Waiau 9	5	8	0.08%	0.14%	-0.05%
Waiau 10	1	8	0.02%	0.14%	-0.12%
Kahe 1	238	311	4.03%	5.29%	-1.25%
Kahe 2	207	271	3.51%	4.61%	-1.09%
Kahe 3	235	261	3.98%	4.44%	-0.46%
Kahe 4	310	350	5.27%	5.95%	-0.68%
Kahe 5	624	654	10.60%	11.11%	-0.51%
Kahe 6	529	530	8.98%	9.00%	-0.03%
CIP1	93	84	1.59%	1.42%	0.16%
SGS	27	27	0.46%	0.46%	0.00%
Airport DSG	2	1	0.03%	0.02%	0.01%
Kalaeloa Total	1,219	1,107	20.70%	18.80%	1.90%
AES	1,469	1,184	24.94%	20.12%	4.83%
HPOWER	368	368	6.26%	6.26%	0.00%
Total	5,889	5,886			Diff 3.8

Figure A-1
COMPARISON OF PLEXOS TO ACTUALS
NET ENERGY IN GWH



Figure A-1 (continued)
COMPARISON OF PLEXOS TO ACTUALS
NET ENERGY IN GWH

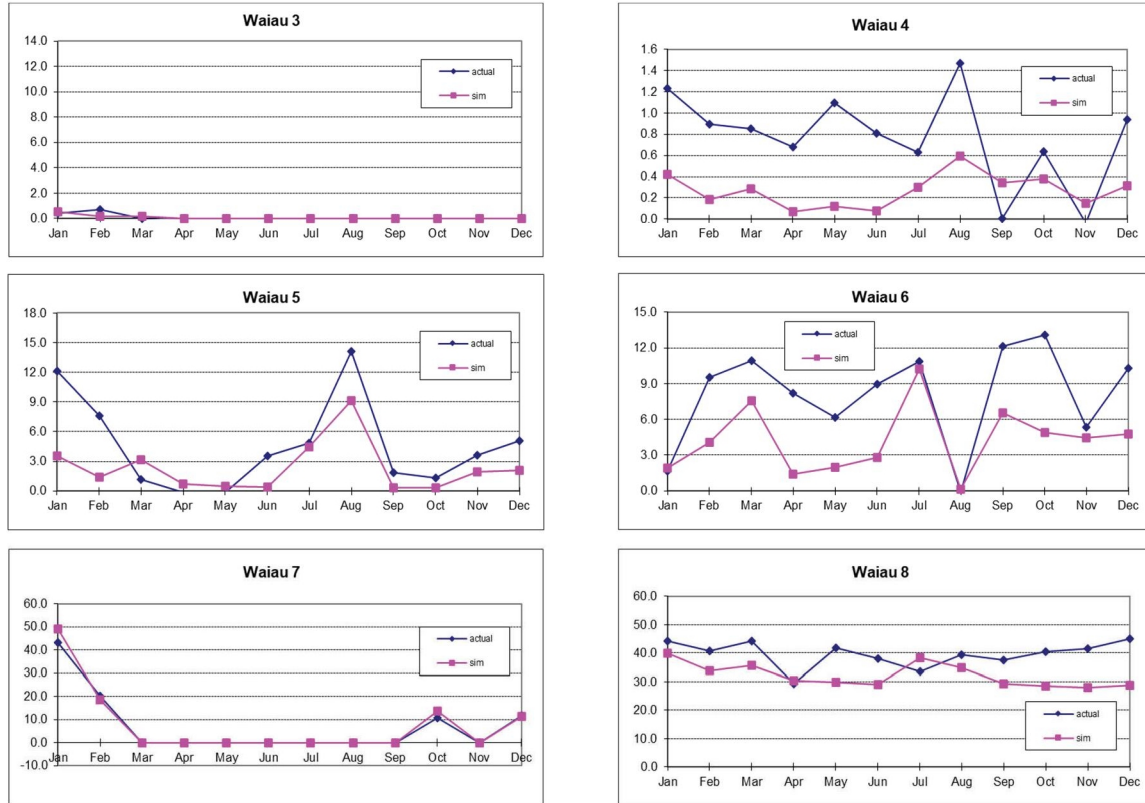


Figure A-2
COMPARISON OF PLEXOS TO ACTUALS
RUNTIME IN HOURS

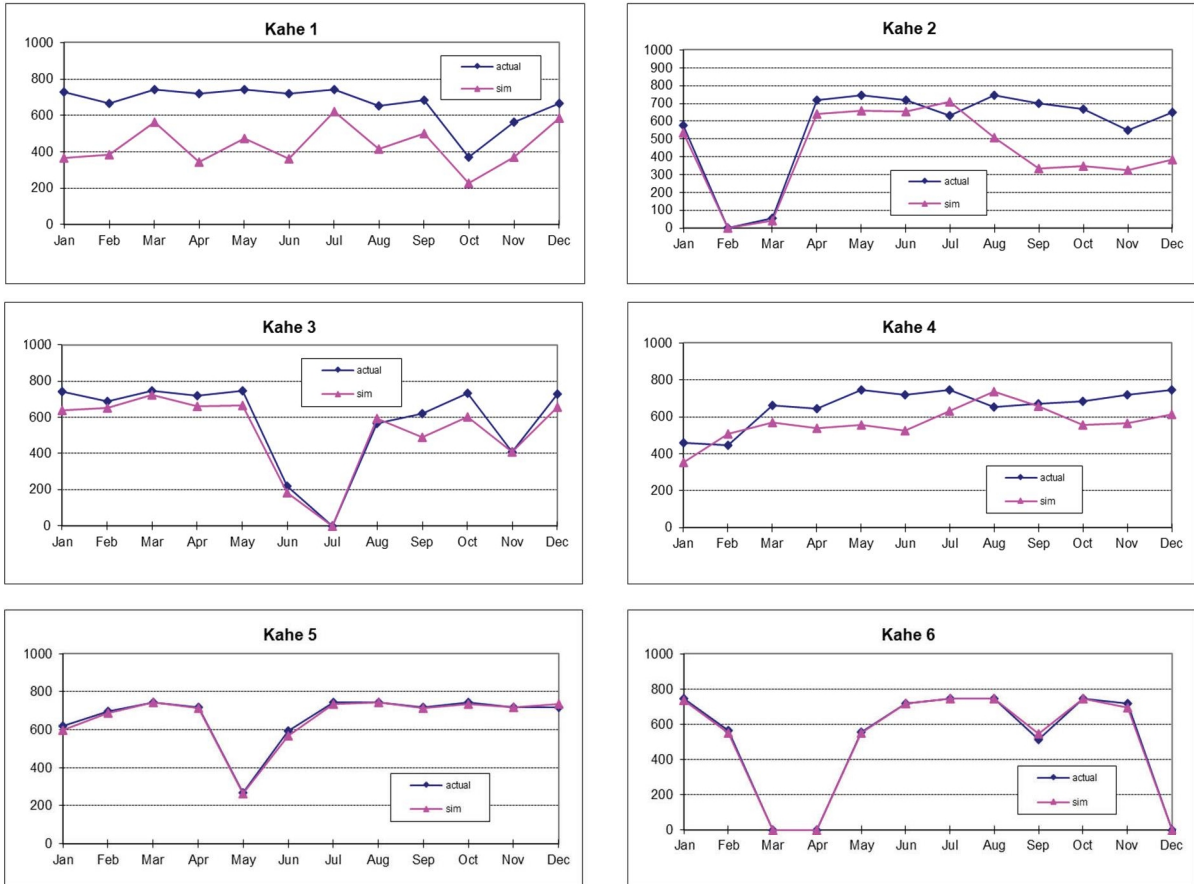


Figure A-2 (continued)
COMPARISON OF PLEXOS TO ACTUALS
RUNTIME IN HOURS

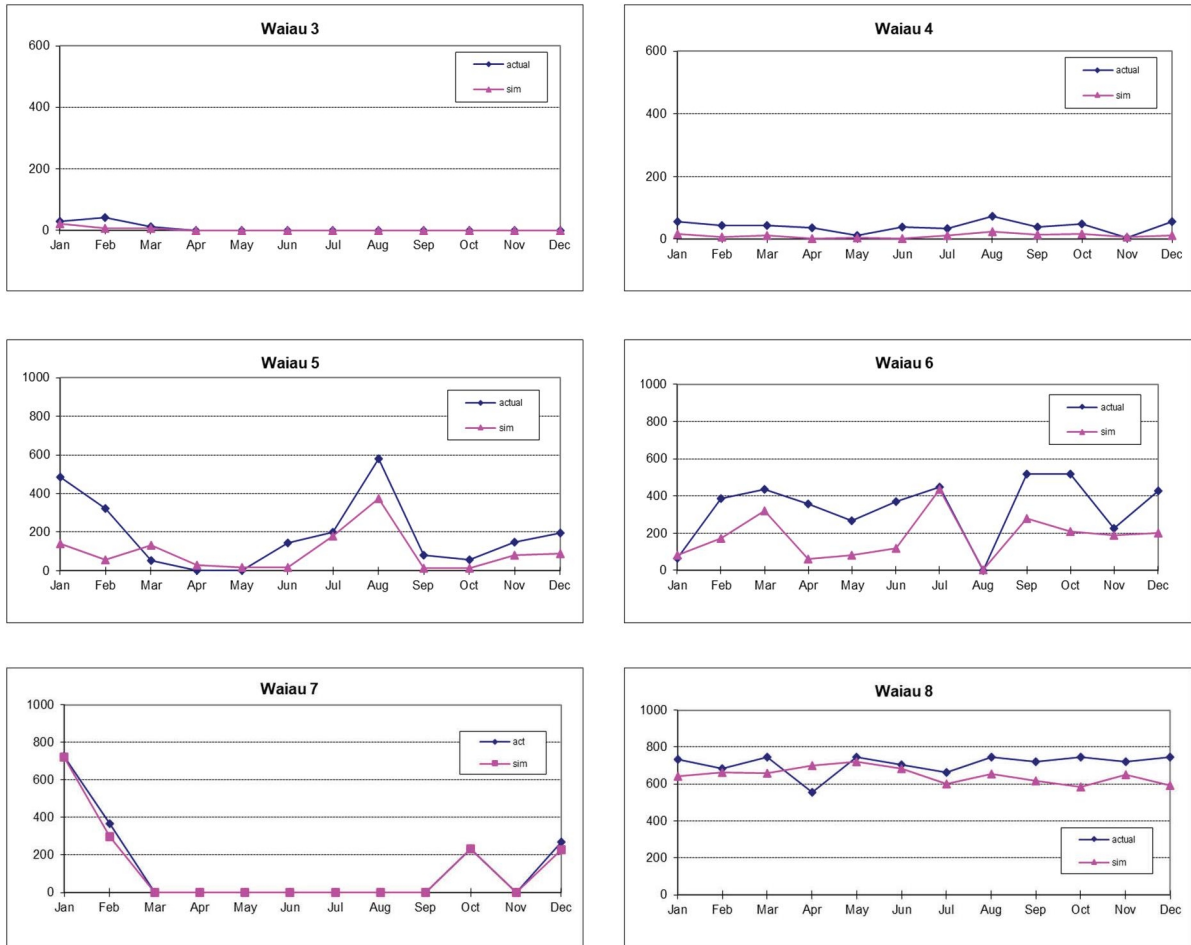


Table B-1
Year 2020 Annual Production Report

UNIT	Generator Net MWH	Run Hours	Fuel Consumption (MBTU)
Kahe 01	311,186	8,004	
Kahe 02	271,074	6,762	
Kahe 03	261,417	6,916	
Kahe 04	350,239	7,892	
Kahe 05	653,844	8,029	
Kahe 06	529,934	6,051	
Kahe Total	2,377,695	43,653	25,321,441
Waiau 03	-1,015	82	
Waiau 04	9,192	490	
Waiau 05	54,942	2,270	
Waiau 06	96,972	4,019	
Waiau 07	84,451	1,596	
Waiau 08	475,910	8,499	
Waiau Total	720,453	16,956	7,937,315

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